

Econ 325: Environmental and Natural Resource Economics
Fall 2007

Problem Set 3: Solutions

Due in class: Thursday November 1, 2007

Instructions: Answer all 7 questions. Please show your work, and be sure to label all graphs accordingly

1. With an inverse demand curve of the form: $P = 20 - 2Q$, (see worksheet ps3 for solutions)

Where P is the exhaustible resource price and Q is the quantity of the exhaustible resource, address the following questions using the Excel Solver function:

- A. Assume that costs of extraction are zero, there are 15 known units of the resource, there are no externalities, and the discount rate is 3%. You have 10 time periods over which to allocate the resource. At what rate should the resource be withdrawn (how many units each year) to maximize monopoly profit?

t=0	1.95
t=1	1.86
t=2	1.76
t=3	1.66
t=4	1.56
t=5	1.46
t=6	1.35
t=7	1.25
t=8	1.13
t=9	1.02

- B. Now suppose that the discount rate falls to 1%. How does this change your answer in (a)?

t=0	1.65
t=1	1.62
t=2	1.59
t=3	1.55
t=4	1.51
t=5	1.48
t=6	1.45
t=7	1.41
t=8	1.38
t=9	1.34

PV increases from \$225.60 to \$244.12

C. Now assume that the Marginal Cost of Extraction is \$2. Using the original discount rate of 3%, how does this change your answer to (a)?

t=0	1.88
t=1	1.80
t=2	1.72
t=3	1.64
t=4	1.55
t=5	1.47
t=6	1.38
t=7	1.28
t=8	1.18
t=9	1.09

PV decreases from \$225.60 to \$198.82

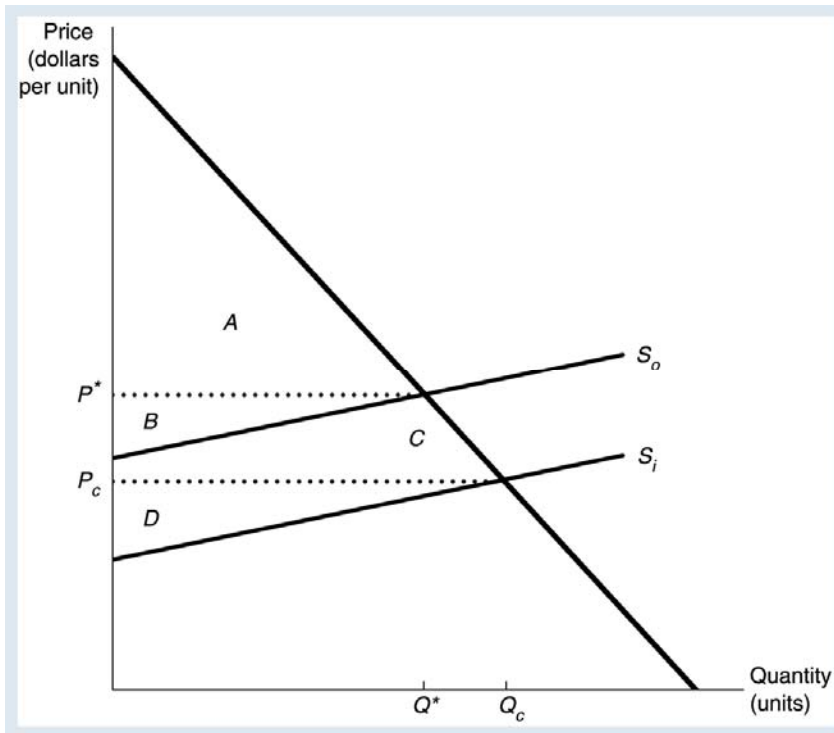
D. Now assume that a new discovery is made (at t=0) and the amount of the resource doubles to 30. How does this change your answers to (a) through (c)?

Quantities, PV increases compared to Q = 15 case. Decrease in discount again increases quantities, PV. MEC will decrease quantities, PV. See solutions for exact extraction rates

2. Why does marginal user cost change as the resource is used through time?

Marginal user cost changes through time because it is a reflection of scarcity, and as the resource becomes more scarce MUC will rise (at the rate of discount), independent of the MEC. Marginal user cost is the opportunity cost of not having the oil available at other periods in the future.

3. With the aid of a graph, explain the effect of price controls on natural gas or oil. Are producers and consumers better off? Discuss why or why not.



- price ceiling reduces MUC (higher future prices no longer possible)
- consumers better off today (gained BC)
- producers not better off: overproducing, so giving up scarcity rent could have gotten without price controls (area D only measures current profit)
- as resource depleted, supply curve shifts up (reflecting higher extraction costs)
- when mc reaches price ceiling, $Q_S=0$
- but demand is not zero at that price: shortages
- suppliers willing, demanders willing, but price control will not allow
- overallocation to current consumers, underallocation to future consumers
- losses to future consumers/producers are greater than gains to current consumers

4. Listen to the 4 minute news clip from October 17, 2004, “Searching for factors behind oil’s steep rise” by clicking on:

<http://www.npr.org/templates/story/story.php?storyId=4112999>

If this link does not work, visit the National Public Radio website at www.npr.org and search for *oil's steep rise* using the search command.

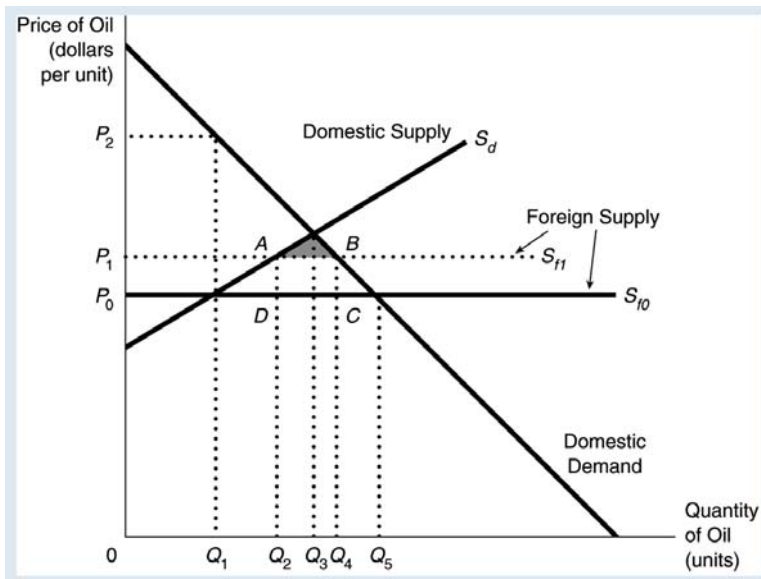
What reasons do the analysts provide for the rising price of oil?

Major world economies growing; US using more oil; Asia using more, demand increasing; Hurricane Ivan limited supply; Russia saga; events around world; labor strike in Nigeria; political instability in Venezuela; fear driving up oil prices; large investment funds buying up oil futures; higher volatility; fears about Middle East, terrorist attack – hedge buying to protect against event.

Explain and supplement their analysis using the concepts of Marginal User Cost and scarcity.

The price of oil, at any particular time t , can be represented by $P_t = MUC_t + MEC_t$. The most important thing to be noted about this equation is that one can predict changes in the price of oil by predicting changes in the marginal extraction cost and the marginal user cost. With fears about tensions in the Middle East, Nigeria, and Venezuela, the opportunity cost (MUC) of using a barrel of oil rises. Although MEC may not change, uncertainty about continued availability of oil in these countries dramatically increases MUC. As a result, MUC rises and price rises.

5. With the aid of a graph, explain why importing oil is still preferred to self-sufficiency, despite the threat of embargos and the cost of foreign dependence on oil.



- With embargo:
 - ❑ consume Q_1 at price of P_2
 - ❑ supply curve assumes enough time to develop the resources
 - ❑ if embargo hits, not enough time – in short run supply curve becomes perfectly inelastic at Q_1
 - ❑ price rises to P_2 to equate supply & demand
 - ❑ huge loss in CS
- With self-sufficiency
 - ❑ domestic supply = domestic demand
 - ❑ net benefits from $Q_3 < \text{net benefits from } Q_4$
(efficient allocation)
 - ❑ efficiency loss shaded triangle
- Better off importing
 - ❑ vulnerability premium lower than cost of self sufficiency
 - ❑ embargos not certain events
 - ❑ can reduce vulnerability (strategic reserves)
 - ❑ using more domestically incurs user costs by lowering amounts available for future
 - ❑ paying vulnerability premium creates more efficient balance btw present/future

6. Discuss the efficient allocations for surface and groundwater. Why are these different?

- Efficiency for surface water
 - balance btw users
 - marginal net benefit equal across users
 - handle variability
 - above-average and below-average flows must be accommodated

- Efficiency for ground water
 - if withdrawal > recharge, eventual exhaust resource
 - MEC rises over time as water table falls
 - pumping would stop:
 - no water left
 - MC pumping > benefit of water or MC of backstop resource (desalination)
 - price rises over time until choke price or switch point

- different:
 - surface
 - how to allocate a renewable supply among competing uses
 - intergenerational effects less important (future supplies depend on natural phenomenon, e.g. rain, rather than current allocation)

 - ground
 - withdrawing now affects future supply

7. Illustrate and describe two approaches to “getting the prices right” for water.

